

Partition and method for controlling the temperature in an area

The present invention relates to a partition for separating two areas, comprising two translucent separation walls located a distance (a) of more than 5 mm apart, wherein means are provided for moving a liquid between said separation walls, said means comprising liquid dispensing means arranged to provide a liquid film, wherein one of said separation walls is an external separation wall and the other of said separation walls is an internal separation wall, wherein said liquid film moves over said internal separation wall.

In US 4 286 576 A a vertically positioned panel for a solar collector with two spaced separation walls located is described, between which separation walls an auxiliary wall has been placed. A liquid is introduced into the two spaces thus produced. This construction serves for the storage of solar energy and is translucent.

A "solar boiler" is described in European application 022 389. That is to say, two walls a small distance apart are fitted in a roof element and the space between them is completely filled with liquid, such as water. Heat can then be extracted by solar radiation. A space remains on either side between the walls and the actual roof element.

In horticulture, but also in other building constructions, there is the problem that on irradiation with sunlight a rise in temperature takes place in the area concerned. It is, of course, possible to eliminate this rise in temperature by ventilation, assuming that the ambient temperature is sufficiently low. However, this produces an open communication to the surroundings, which under certain circumstances is not desirable. Moreover, it is very well possible that the outside temperature is so high or low that active cooling or heating, respectively, is required.

The aim of the present invention is to provide a partition and method, respectively, by means of which active cooling, or alternatively heating, is possible and as a result of which further ventilation or heating can be dispensed with. The aim of the present invention is, furthermore, to implement cooling/heating in such a way that there is no or negligible loss of light from any luminous radiation passing through the partition.

This aim is realised according to the invention with a partition as described above, wherein one of said separation walls is an external separation wall and the other of said separation walls is an internal separation wall, wherein said liquid film moves over said internal separation wall and there is a thermally insulating space between said liquid film and the external separation wall.

The invention can be used both with vertically positioned partitions and with partitions at an angle. In the case of partitions at an angle, the angle with respect to the horizontal is preferably at least 20°. An example of such a partition can be found in the roof construction for a greenhouse.

5 The present invention relates to a separation wall between two areas and not to a solar collector that can be installed independently. The thermally insulating space preferably comprises a space for accommodating an insulating gas, such as air.

According to a particular embodiment of the invention, in contrast to the constructions known to date, a liquid film is fed over the internal separation wall. However,
10 such a liquid film has such small dimensions that a free space or cavity that provides insulating properties remains between the top face of the liquid film and the external separation wall. That is to say, the effect of the heating of water disclosed in European application 022 389, which has been described above, does not arise in the case of the present invention because the water is not in contact with the external separation wall and
15 is even insulated with respect to that separation wall. If water or another crystal-clear liquid is used, in principle the light will be transmitted without substantial loss, that is to say with an efficiency of more than 95 % and more particularly with an efficiency of more than 99 %, as a result of which negligible heating of the water caused by solar radiation takes place.

20 Because, however, the water flows over the internal separation wall, the temperature of the internal separation wall will approach the temperature of the water. After all, if made of plastic, such separation walls are generally made thin-walled with a wall thickness of less than 3 mm and in particular less than 1 mm and more particularly approximately 0.2 mm. This wall thickness is dependent on the material used and for polycarbonate, for
25 example, is approximately 0.8 mm and for PMMA is approximately 2 mm and for film is approximately 0.07 mm.

Because the wall assumes the temperature of the cool or warm water, active cooling of the area is produced. If humidity is relatively high, condensation, that is to say relinquishing of heat, will occur at the wall. Such formation of condensation on the inside
30 of the wall can lead to water droplets that drip from the separation wall in an undesirable manner. This can be avoided by providing the inside of a wall with additives or coating that lower the surface tension. It is also possible to promote droplet formation/condensation with the aid of targeted circulation along the inside of the partition. Other means to

promote condensation that is as distributed as much as possible can be used, such as vibration means. Because of the presence of the "cavity" above the water layer and below the external separation wall, a cavity that has an insulating effect is produced. As a result of this insulation the absorption of heat by the building construction will be prevented by the presence of the cooling flow of water. Any condensation in the space inside the building construction will be restricted to a minimum and will always occur at the coldest point, that is to say at the internal separation wall.

To ensure that the water or other liquid, such as glycol, is distributed as far as possible over the surface of the internal separation wall, agents that lower the surface tension, such as types of soap, can be used. These can be present both in the liquid concerned and on the internal separation wall over which the water flows. It will be understood that said internal separation wall does not always have to be fitted at an inclination. This can also be vertical.

The liquid can also have a high viscosity, that is to say this is relatively viscous. Starting with water, this can, for example, be achieved by adding thickeners thereto.

Between the top of the water surface and the bottom of the top or external separation wall there can be either air or a liquid sealing layer. This can be a permanent further intermediate panel completely filled with the liquid. It is also possible to use a flexible film, in which case the water "creeps" between the film and the top of the internal separation wall. The thickness of the liquid film is preferably less than 5 mm, such as 3 mm, or less than 1 mm. Such a liquid sealing layer is preferably used in combination with a partition positioned at an inclination. Instead of the film described above, this can also comprise a non-woven made of any material that floats on the liquid.

The mechanism of the present invention is preferably such that the flow rate of the liquid and the temperature control the quantity of heat absorbed or released. In principle, a basic quantity of liquid is always present as separator.

The liquid used has a preferably relatively low temperature. A temperature of between 5 °C and 12 °C is mentioned as an example. By this means it is possible to absorb and to remove a large amount of heat from the building construction. The heated/cooled water can, for example, be returned to a heat sink, which, for example, can be an underground water store. In the winter this water that has been heated to some extent can be used again to heat the building construction, either directly or via a heat pump. In the shorter term, such as during the night, it is possible to provide for further cooling of the

water previously used. Other constructions with storage vessels, heat pumps and heat exchangers can be envisaged by those skilled in the art and fall within the scope of the appended claims.

The liquid released can be discharged in any manner known in the state of the art.

5 According to a particular embodiment of the present invention, a series of nozzles is provided along the top boundary of the panel concerned, each of which dispenses a distributed stream of water. It is also possible to provide for continuous dispensing using special dispensing hoses or tubes designed for this purpose. Moreover, the supply and discharge, respectively, can be integrated in a panel that forms the partition. In particular,
10 the panel can be provided with a frame at the bottom and top for discharge/supply.

According to a further variant of the invention, the external panel is permanently fitted in a building construction and the internal panel over which the liquid flows is fitted such that it can be displaced. In this context, consideration can be given to a screen or film layer over which the liquid moves and which can be removed as required, for example by
15 rolling up. Preferably, some of the liquid is also included when rolling up, to facilitate realisation of the water film at a later stage by the liquid that is then present between the windings. The material of such an internal separation wall is preferably a polyamide and more particularly polyamide 6.6. It must be understood that this can also be used for the other walls comprising the liquid sealing layer. Other plastic materials known in the state
20 of the art, but also glass, can be used for the separation walls.

The invention also relates to a method for controlling the temperature in an area, which area is provided with an inclined, translucent partition consisting of transparent separation walls at least 5 mm apart, wherein one separation wall constitutes the boundary with said area and the other separation wall constitutes the boundary with said
25 surroundings, wherein a liquid film is applied on the top of the separation wall that constitutes the boundary with the area, such that the top of the liquid film is some distance away from the bottom of the other separation wall, wherein an insulating gas, such as air, is arranged in said space, wherein the heat transport to/from said area is determined by controlling the amount of liquid supplied/discharged. According to the invention a liquid
30 film is, in principle, continuously present and the temperature within said area can be influenced by changing the flow rate, in combination with the temperature. The insulation with the other separation wall preferably consists of a space filled with gas, such as an air-filled space.

It has been indicated above that in principle the liquid used is crystal-clear, that is to say has no influence on the light transmitted. However, it is possible to provide for influence by means of additives in the liquid and/or coatings on the walls.

Additives that influence the wavelength of the light are mentioned as an example. In particular when cultivating plants in greenhouses it has been found that certain parts of the light spectrum are important and other parts are less important for growth. Apart from influencing the wavelength, it is possible to keep out certain undesirable frequencies. Moreover, a continuously variable control of the light transmission and/or reflection can be provided in that a continuous stream of water moves over the internal separation wall of the panel. It will also be understood that, in contrast to what has been described above, absorption of heat can take place by the addition of pigment and other substances and/or the provision of coatings.

It is also possible to influence the emergence of light from the building construction by introducing additives. In greenhouses, for example, screens are used at night to restrict the emergence of light. These could be replaced by (temporarily) introducing additives into the liquid. At a later stage these additives can be chemically or physically removed in a simple manner. In addition, it is, moreover, possible by means of these additives to recover the heat that is produced by lighting (assimilation lighting) by absorption. Another possibility at relatively high temperature is to cool down this heat using the liquid according to the invention.

Moreover, it is possible to introduce additives into the liquid by means of which chemical/physical processes are possible under the influence of radiation, such as forms of photosynthesis. Another example is the introduction of additives that react to an electric current that is applied to the liquid film.

Instead of or in addition to the additives that influence the chemical/physical properties of the liquid, in the case of the use of a film layer or the like that encapsulates the liquid, it is possible to provide this film layer with properties that give rise to, influence or intensify the effect of the additives that has been described above. In this context such a film can, for example, be fitted such that it can be displaced. That is to say, a film may or may not be present in the space delimited between the separation walls.

The heat transfer to the interior of the building construction can be managed by controlling the flow rate, the temperature and the layer thickness of the water. The layer thickness of the liquid stream can also be influenced by means of additives.

Agents that restrict or stimulate thermal radiation can also be added to the liquid. This can, of course, also be achieved in the form of a coating on one of the separation walls.

Because the water flow is supplied individually at different locations, different conditions can be achieved at different positions in the building construction. Certain
5 advantageous situations can be achieved in this way.

According to a further advantageous embodiment of the invention, the entire space between the two separation walls can be temporarily filled with liquid. In such a case a construction similar to a solar boiler is produced by means of which heat can be extracted. In the case of complete filling the effect of cooling is produced at night. The walls, and in
10 particular the internal separation wall, can be provided with means to improve the heat transfer. Examples of these are ribs, black-coloured parts and the like.

The invention will be explained in more detail below with reference to an illustrative embodiment shown in the drawing. In the drawing:

Fig. 1 shows, highly diagrammatically, a building construction;

15 Fig. 2 shows, in detail, part of the roof of the construction;

Fig. 3 shows a further variant of a partition wall in cross-section, and

Fig. 4 shows another embodiment of the construction according to the invention.

In Fig. 1 a building construction such as a greenhouse is indicated by 1. The roof or cover is indicated by 2. As can be seen from Fig. 2, this consists of partitions 3. Each
20 partition consists of an external separation wall 4 and an internal separation wall 5. With this arrangement the external separation wall 4 is the wall that is in contact with the surroundings and the internal separation wall 5 is the wall that is in communication with the area. The distance between the walls 4 and 5 is indicated by a and is greater than 5 mm and preferably greater than 1 cm. The walls can be made of glass or a plastic material of
25 small wall thickness. For glass the wall thickness is preferably less than 5 mm and for plastic is less than 2 mm and more particularly less than 1 mm, such as 0.1 mm. Polycarbonate, polymethyl methacrylate, polyamide, such as polyamide 6.6, and the like are mentioned as examples for the plastic.

At the top of the cover there is a water supply line 7 with dispensing nozzles 6. By
30 dispensing water a water layer 10 that extends over a large proportion of the surface of the internal separation wall 5 is produced over the latter. This water layer 10 has a relatively small thickness, that is to say a thickness of less than 2 mm and preferably approximately 1 mm. In any event the thickness of the water layer that is indicated by b is substantially less

than the abovementioned distance a , so that a free space remains between the top of the water layer 10 and the external separation wall 4, which space is filled with gas, such as air. This space acts as insulation.

Water preferably flows over the sloping parts of the internal separation wall 5. A wide, relatively thin water layer can be ensured by using agents that lower the surface tension. The effects described above in the preamble to the description can be obtained with the aid of this water layer. That is to say, in contrast to constructions according to the state of the art, no heating of the water takes place because this is in principle crystal-clear. Of course, other crystal-clear liquids can be used instead of water. By the use of/additives in the water, the light transmission characteristics can be influenced and heat can optionally be absorbed or released or the incidence/radiation of light can be influenced.

A further embodiment of the invention is shown in Fig. 3. The panel is indicated in its entirety by 13 and forms part of a building construction. There is an inclined upper or external separation wall 14 and, arranged a distance a away from the latter, a lower or internal separation wall 15 extending essentially parallel thereto. A liquid film that has a thickness b is indicated by 20. This liquid is dispensed from nozzles 17 and flows downwards under gravity. A layer of film 21 "floats" on the liquid. A distance c that is filled with gas, such as air, remains between the top of the film layer 21 and the bottom of the upper panel 14. The resulting space is indicated by 18 and provides insulation. This film can be an oriented polyamide with, for example a thickness of 25 μm .

With this construction it is possible to move a continuous film of water with a thickness of from 0.5 mm downwards. The thickness of the film of water can be greater if a film layer or other encapsulating layer is used. A value of 2 - 3 mm is mentioned as an example. In the embodiments shown here, the top of the lower separation wall is preferably essentially flat, that is to say there are no ribs or channel structure. The film used here, on its own or in combination with the liquid, can have changing optical properties, for example under the influence of an electrical voltage applied thereto. Moreover, it is possible to prevent a growth of matter by means of such a voltage.

It is also possible to change the optical properties of the incident light by means of suitable additives to either the film layer or the liquid. One of the possibilities is to change the angle of reflection such that light is no longer able to leave the greenhouse via the liquid and/or film. Moreover, the various aspects can be implemented in such a way that radiation of the infrared component of the light is counteracted.

In Fig. 4 part of the construction according to the present invention that is located close to a gutter is shown as an alternative. It will be understood that the same construction can be incorporated in any other location in a building construction, such as at a girder where there is a frame for collecting liquid, which optionally is integrated in a housing, which contains the roll-up section as to be described for Fig. 4. This gutter is indicated by 25. The external separation walls are indicated by 26 and 27, respectively. There is a window 28 that can be swung open in one external separation wall 26. The operation of this window can be effected by means of any construction known in the state of the art. According to a particular embodiment according to the invention, with this arrangement use is made of a scissor-like construction that is located in the plane of the external separation wall 26, as a result of which the liquid stream remains unimpeded. The internal separation wall is indicated by 30 and 31, respectively. The liquid flows over this. There is a roller construction 32 by means of which the internal separation wall can be rolled up, that is to say can be removed. Preferably, rolling up takes place in a situation in which the internal separation wall is damp, so that subsequent unrolling is facilitated. After the internal separation wall has been rolled up, this will not constitute any impediment to the light passing through.

The gutter 25 is a special construction. This contains an upper channel 32 for removing rainwater. For this purpose there is an opening 33 in cover 34. Furthermore, there are channels 35 that, via the openings 36, collect and remove the liquid originating from the liquid film that is moving over the internal separation wall. This takes place separately on the left and the right. There is a further channel 37 for the condensation collecting on the inside of the internal separation wall 30, 31. A fixing for the internal separation wall 31 that can be rolled up is indicated by 38. That is to say the roller 32 moves towards the fixing 38 when rolling up and away from the fixing 38 when unrolling.

In the examples described above the water moves over the internal separation wall of the partition. However, it is also possible to move the liquid over the external wall that is to say over wall 27 in Fig. 4.

In the embodiment according to Fig. 4, it will still be possible to move a liquid film over internal separation wall 30 when the window 28 is opened. This liquid enters into interaction with the surroundings when window 28 is opened.

In the embodiment shown here, where the water moves over the internal separation wall, the external separation wall can be provided with a coating that counteracts condensation in order thus to influence the translucency as little as possible.

As a result of the use of plastic panels, a relatively small wall thickness can suffice,
5 as indicated above. Because plastic can be made more translucent than glass and as a result of the smaller wall thickness thereof, a particularly high light transmission can be obtained in combination with a crystal-clear liquid. Moreover, the weight of the construction can be limited appreciably compared with constructions that are made up of double glazing. However, the use of glass is still a practical option.

10 The water or other liquid is preferably fed from the nozzles 6 at a relatively low temperature if it is desired to cool the interior of the building construction. A temperature of 5 - 12 °C is mentioned as an example if the aim is for a rise in temperature of the liquid film 10 of more than 20 and preferably approximately 30 - 40 °C. The temperature of the water must not be so low that freezing can occur.

15 By temporarily filling the space between the walls 4 and 5, a conventional solar boiler or cooling construction can be provided.

Although the invention has been described above with reference to a preferred embodiment, it will be understood by those skilled in the art that numerous modifications can be made thereto without going beyond the scope of the present application as described
20 in appended claims.